

84 Mr

g. 2

EFFECT OF HARVEST DATE,
STORAGE PERIOD,
AND RIPENING TIME
ON THE QUALITY
OF CHINESE GOOSEBERRIES

Marketing Research Report No. 940

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
RECEIVED

OCT 24 1977

PROCEDURE COLLECTION
CURRENT SERIAL RECORDS

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

ACKNOWLEDGMENT

The cooperation of R. C. Smith, U.S. Plant Introduction Station, Chico, Calif., in providing information and fruit for these tests is gratefully acknowledged.

CONTENTS

	Page
Summary.....	1
Introduction.....	1
Materials and methods.....	2
Results.....	3
Firmness.....	3
Weight loss.....	4
Color.....	7
Soluble solids content.....	7
pH.....	8
Titratable acidity.....	8
Discussion and conclusions.....	9
Literature cited.....	10

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

Effect of Harvest Date, Storage Period, and Ripening Time on The Quality of Chinese Gooseberries

By C. MAX HARRIS, *plant physiologist*; H. MELVIN COUEY, *plant physiologist*;
and JOHN M. HARVEY, *investigations leader*, Market Quality Research Division,
Agricultural Research Service

SUMMARY

Chinese gooseberry (*Actinidia chinensis* Planch.) fruit softened slowly during storage at 32° F., but the rate of softening increased with storage time. Increase in deformation of fruit, under a 1-kilogram load, ranged from 0.3 to 0.7 millimeters per month when stored at 32° and increased an average of 0.3 mm. per week during ripening at 70°. Most fruit were edible after storage for 12 weeks at 32° without further ripening.

Fruit softening during storage was accompanied by a decrease in acidity and an increase in percent soluble solids. The increase in soluble solids occurred primarily at the stem end of the fruit.

Weight loss averaged 0.3, 1.1, and 4.0 percent after storage at 32° F. for 4, 8, and 12 weeks, respectively, and ranged from 1.0 to 2.0 percent per week during holding at 70°.

No significant changes in flesh color were found during storage and ripening of the fruit.

INTRODUCTION

The Chinese Gooseberry (*Actinidia chinensis* Planch), also known as Kiwi fruit, was brought to California about 45 years ago by research workers at the U.S. Plant Introduction Station at Chico. In 1961, the plant was released by that station as a potential new fruit crop for the United States (10)¹. Since that time, small, but expanding, plantings of the vine have been made in suitable growing areas of California. A recent report (4) indicates that future acreage may increase greatly as the fruit becomes more widely known.

Studies in New Zealand have shown differences in storage quality and vitamin C content among several varieties of Chinese gooseberry

¹ Italicized numbers in parentheses refer to Literature Cited, p. 10.

(7, 9). Reports also indicate that the fruit is nonclimacteric (11), has an optimum storage temperature of 31° to 32° F. (5, 7, 8, 9), and requires a relative humidity of 90 to 95 percent during long storage to minimize moisture loss (5, 6).

Little work has been done on the postharvest handling of Chinese gooseberries in the United States. Because of the potential commercial importance of the crop, more information was needed on the physiological changes that occur in the fruit during storage and ripening, on the optimum dates for picking the fruit for immediate marketing or for storage, and on other factors affecting the postharvest quality of the fruit.

MATERIALS AND METHODS

Fruit was obtained from the large "mother" vine at the U.S. Plant Introduction Station at Chico, Calif., in 1967, 1968, and 1969. This vine is a Plant Introduction numbered selection (P.I. 112053), but is similar to the Hayward variety grown in New Zealand.

1967 season.—Fruit was harvested weekly for 5 weeks, beginning on November 21, and was returned to Fresno on the day of picking. Samples of five fruit each were stored in plastic bags perforated with eight ¼-inch holes for 0, 4, 8, or 12 weeks at 32° F. after which they were ripened for 0, 1, or 2 weeks at 60° before examination.

Firmness was measured by squeezing individual fruit between the flat surfaces of an Instron Universal Testing Machine (Model TMM) until they were crushed. The fruit were cut to a uniform length of 1 inch by removing both ends before testing for firmness. Measurements are reported as a ratio of the pressure applied by the moving plate to the distance it traveled, thus, the higher the value, the firmer the fruit.

A Hunter Color and Color Difference Meter was used to measure the green flesh color at both ends of the cut fruit. Care was taken to avoid the lighter flesh and small dark seeds toward the center of the fruit. A standard color plate having a reflectance value ($\bar{R}_d$) = 50.4 and color values of $a = -17.3$ and $b = +7.5$ was used to calibrate the machine.

Percent soluble solids content (ssc) and pH measurements were made on both ends of the fruit using juice squeezed from the end sections, which had been cut off previously. A temperature-compensated hand refractometer was used to obtain ssc.

1968 season.—Pickings were made at 1-week intervals for 3 weeks beginning on November 20. Fruit from this season was generally more mature than fruit picked on the same dates in 1967. Many of the fruits felt slightly soft when squeezed gently, but others were

hard. On this basis the fruit was segregated into "firm" and "hard" categories after each picking. The hard fruit were comparable in firmness to fruit tested in 1967. Samples of five firm and five hard fruits were stored in perforated plastic bags for 0, 4, or 8 weeks at 32° F. after which they were ripened for 0, 1, or 2 weeks at 70°.

Firmness, flesh color, pH, and ssc were measured on individual fruit by the same methods used the previous year. In addition, percent weight loss was determined on the five-fruit samples.

1969 season.—All fruit in the 1969 season was picked on November 19. No other pickings were made due to a shortage of Chinese gooseberries at the Chico station. Samples of five fruit were stored in the perforated plastic bags for 0, 4, 8, 12, or 16 weeks at 32° F., after which they were ripened for 0, 1, 2, or 3 weeks at 70°.

Firmness was again measured with the Instron Universal Testing Machine, but by a nondestructive method (3). Deformation under a 1-kilogram load was recorded for each intact fruit in millimeters. This method allowed the firmness of individual fruit to be measured after removal from storage and again after ripening.

Juice samples for ssc and pH measurements were prepared by quartering individual fruit, pressing the parts in a stainless steel line squeezer, and straining the pulp through cheesecloth. In addition, titratable acid was measured (1, par. 26.28).

Percent weight loss was recorded on samples of five fruit as before.

RESULTS

Firmness

The average rate of softening (deformation) of fruit during the 1969 season increased almost 0.1 mm. per week during the first 8 weeks of storage at 32° F. (fig. 1). Thereafter, fruit softened at about twice that rate. Most fruits removed from storage after 12 and 16 weeks were edible without further ripening at 70°. Deformation values after ripening at 70° depended to a great extent on the firmness of the fruit when removed from 32° storage (table 1)—differences in firmness after storage continued through the ripening period. The average increase in deformation at 70° was about 0.3 mm. per week.

Statistical analysis of the data from the 1969 season showed that both storage and ripening times had a significant effect on fruit firmness (table 2). Statistical differences in firmness during storage and ripening periods occurred toward the end of the storage or ripening.

Fruit firmness at harvest decreased steadily during weekly pickings from November 21 through December 19 in 1967, and these differences in firmness were generally maintained during storage at 32° F. (fig. 2).

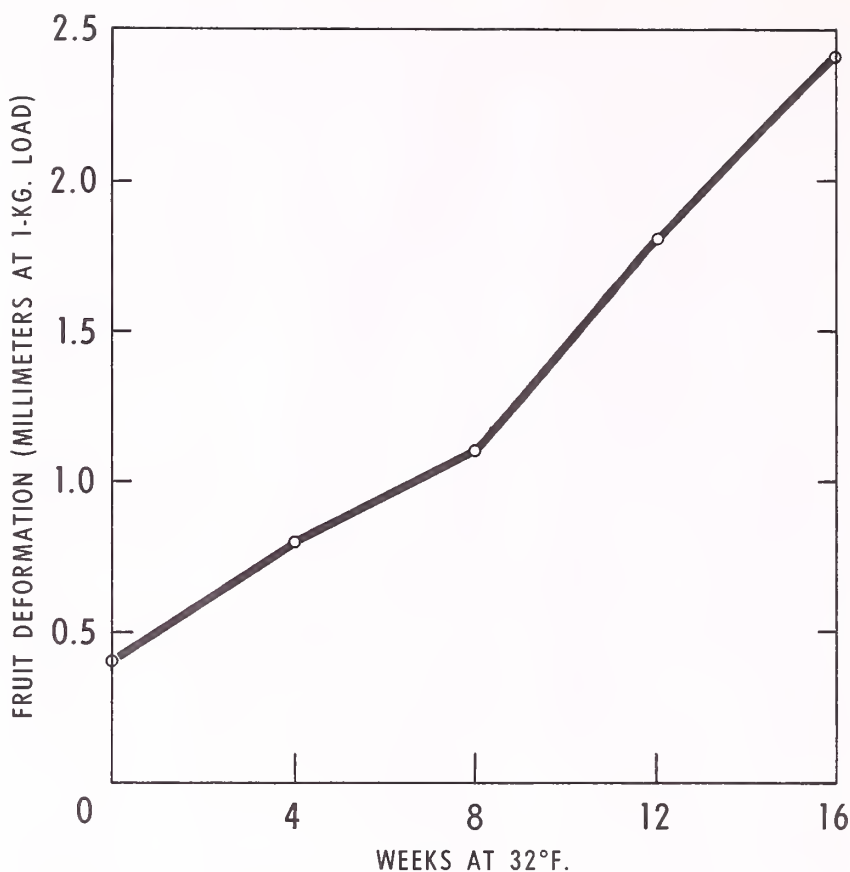


FIGURE 1.—Changes in firmness of Chinese gooseberries during storage (1969).

Weight Loss

The percent weight loss from fruit held at 32° F. (fig. 3) followed the same general pattern as values for fruit firmness (fig. 1). Weight loss was 0.3 and 1.1 percent after 4 and 8 weeks' storage, respectively, after which it increased to 4 percent after 12 weeks and 6 percent after 16 weeks. Weight loss from fruit was 1 to 2 percent per week during holding at 70° (fig. 3).

Weight losses from hard fruits during the 8 weeks of storage and 2 weeks of ripening during the 1968 season were similar to those from hard fruit during 1969, and only slightly higher from firm fruits than in 1969.

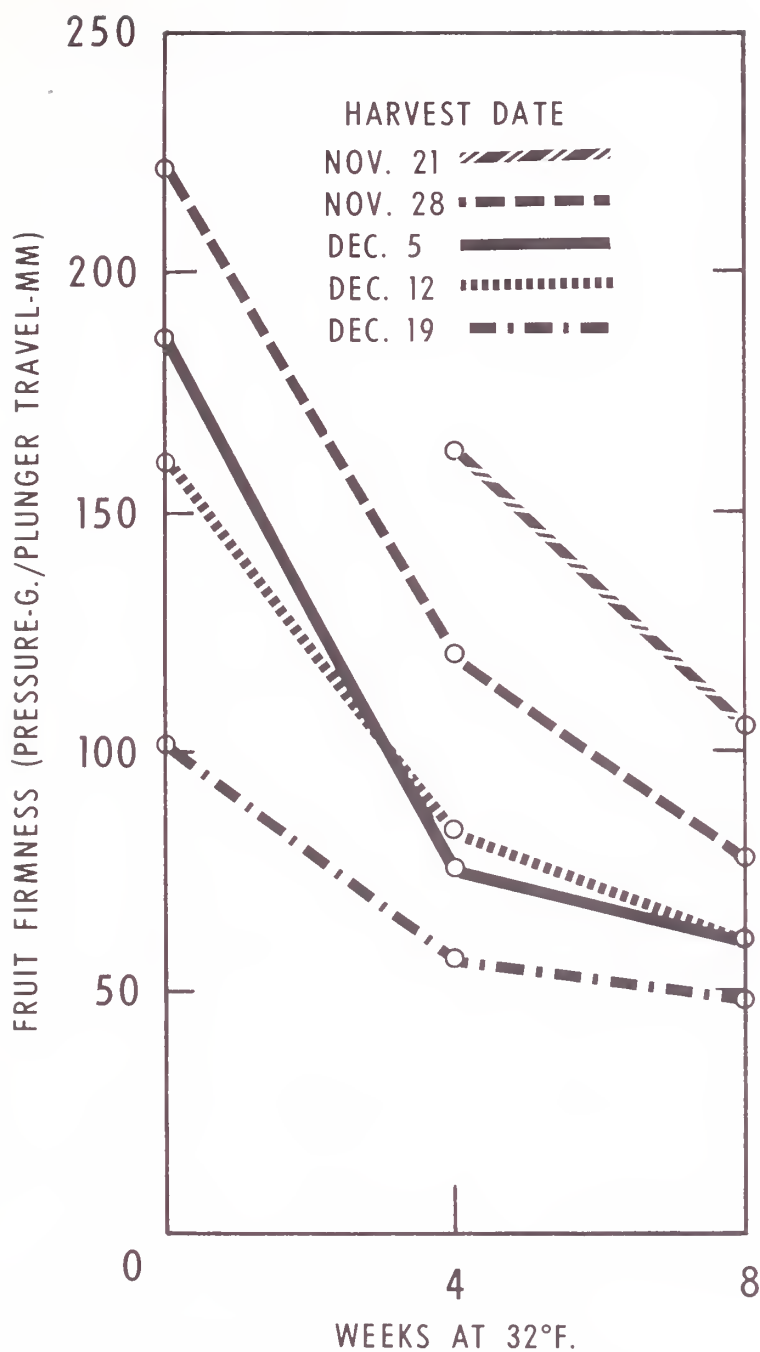


FIGURE 2.—Effect of harvest date on initial fruit firmness and changes in firmness during storage at 32° F. (1967 season). Initial value for first harvest is missing.

TABLE 1.—*Effect of fruit firmness, after storage, on subsequent ripening of Chinese gooseberries in 1969*

Weeks of storage at 32° F.	Lot No. ¹	Deformation ²			
		After storage at 32° F.	After ripening at 70° F. for indicated number of weeks		
			1	2	3
0-----	1	0.4	-----	-----	-----
	2	-----	0.9	-----	-----
	3	-----	-----	1.3	-----
	4	-----	-----	-----	1.2
4-----	1	1.2	-----	-----	-----
	2	1.1	1.4	-----	-----
	3	.7	-----	.9	-----
	4	.7	-----	-----	1.4
8-----	1	1.1	-----	-----	-----
	2	.9	1.2	-----	-----
	3	1.1	-----	1.6	-----
	4	1.0	-----	-----	2.3
12-----	1	1.5	-----	-----	-----
	2	1.9	2.3	-----	-----
	3	1.9	-----	2.4	-----
	4	1.9	-----	-----	3.3
16-----	1	2.2	-----	-----	-----
	2	2.3	(3)	-----	-----
	3	2.6	-----	-----	-----
	4	2.5	-----	-----	-----

¹ 5 fruit per lot.

² Millimeters deformation of fruit under a 1-kg. load.

³ All lots were ripe after storage at 32° F.

TABLE 2.—*Effect of storage at 32° F. and subsequent ripening at 70° on fruit firmness, pH, and percent soluble solids content in 1969*

Ripening index	Weeks of storage at 32° F.					Weeks of ripening at 70° F.			
	0	4	8	12	16	0	1	2	3
Firmness ¹ -----	² 0.9a	1.2a	1.6a	2.4 b	2.5 b	1.3a	1.6a	1.7ab	2.3 b
Soluble solids percent-----	13.9a	15.5 b	15.5 b	16.2 b	16.4 b	14.7a	15.8a	15.8a	15.7a
pH-----	3.47a	3.54a	3.56a	3.71 b	3.70 b	3.51a	3.59a	3.59a	3.69a

¹ Millimeters deformation of fruit under a 1-kg. load.

² Means for a given factor and storage condition having no letter in common differ at the 99-percent probability level.

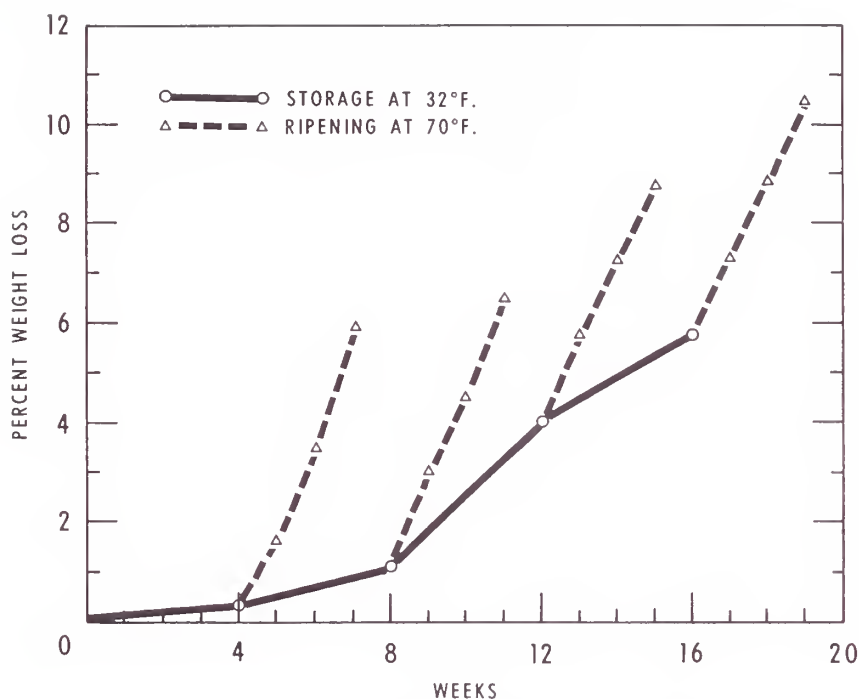


FIGURE 3.—Percent weight loss from Chinese gooseberries during storage and ripening (1969).

Color

Initial fruit color was variable and no consistent changes in color during storage and ripening were found. *Rd* values of all fruit tested ranged from 13 to 42; *a* values from -4 to -15 ; *b* values from $+16$ to $+27$. Mean values for all fruit were $Rd=27.0$, $a=-11.5$, and $b=+24.0$.

Soluble Solids Content

The ssc of juice squeezed from whole fruit (1969 season) was significantly lower at harvest than after storage at 32° F. (table 2). The ssc of juice from the stem end averaged about 3 percent lower than that from the blossom end at time of harvest (fig. 4). During subsequent storage and ripening, the ssc became more uniform throughout the fruit. In 1967, no significant difference in ssc was observed due to picking date when fruit was picked at five weekly intervals beginning on November 21.

pH

Although variable, pH increased significantly during storage at 32° F. in fruit from the 1969 season (table 2). The increase occurred mainly after the second month. When measurements were made on both ends of fruit in 1968, the pH was consistently higher in juice from the stem end than in that from the blossom end (fig. 5). The difference in pH at the ends of the fruit was small initially, but increased during storage, which contrasts with the changes in ssc of the same fruit (fig. 4).

Titratable Acidity

Titratable acidity of fruit juice was significantly higher immediately after harvest in 1969 than after storage for 4, 8, 12, or 16 weeks at 32° F. (fig. 6). Changes in titratable acidity during ripening were variable. The only significant change was a decrease in acid content during 3 weeks of ripening at 70° (fig. 7).

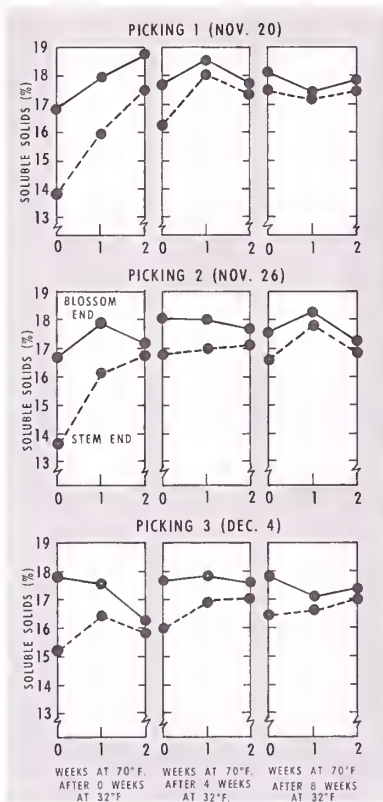


FIGURE 4.—Effect of picking date, storage time, and ripening time on soluble solids content of Chinese gooseberries.

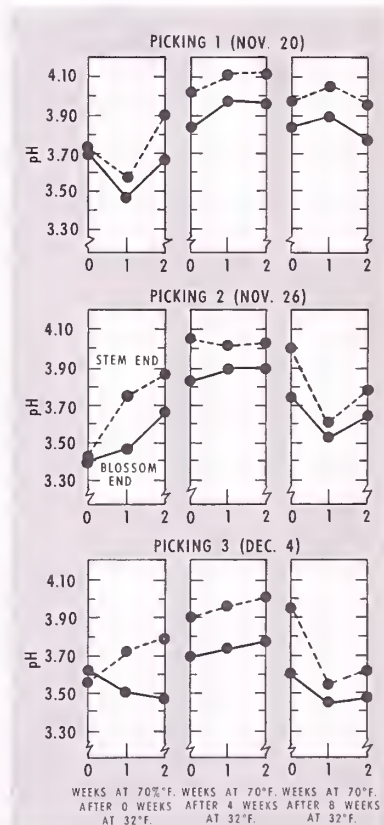


FIGURE 5.—Effect of picking date, storage time, and ripening time on pH of Chinese gooseberries (1968).

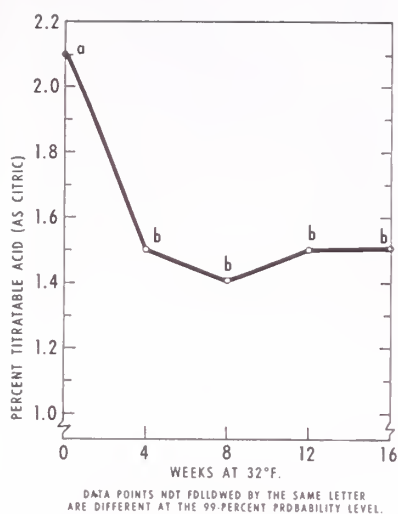


FIGURE 6.—Effect of storage time on percent titratable acids in Chinese gooseberries (1969).

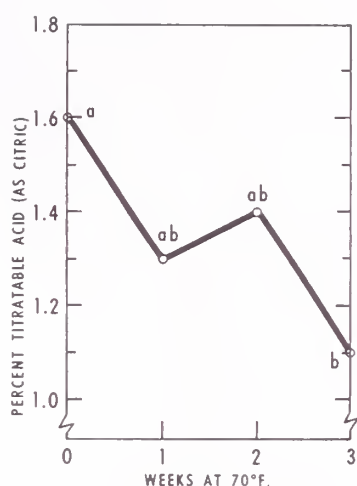


FIGURE 7.—Effect of ripening time on percent titratable acids in Chinese gooseberries (1969).

DISCUSSION AND CONCLUSIONS

The Chinese gooseberry does not undergo clearly defined external changes during development on the vine, and maximum size is reached well before the fruit is fully mature. Time of fruit set and subsequent fruit maturity also can differ from year to year due to variations in weather conditions. These factors make it very difficult to determine optimum harvest dates for Chinese gooseberries. Fortunately, the picking date does not seem to be critical unless maximum storage life is desired. For example, commercial harvesting in New Zealand usually extends from early May to late July (late fall and winter) and fruit picked any time during this period may be stored for about 2 months. For longer storage, however, only fruit picked in the short period from late May to early June was acceptable (7). Experience in growing and harvesting the fruit in a given locality is necessary before optimum picking dates can be predicted.

The most obvious change that occurred in Chinese gooseberries during storage was a general softening, which was the only external indication that the fruit was ripening. Most fruits that deformed at least 2 mm. under a 1-kg. load, after removal from storage, were edible without further ripening.

Sugar, as measured by ssc, continued to increase while fruit was stored at 32° F., and usually reached a maximum value after 4 to 8 weeks; no further increase in ssc occurred when these fruits were ripened at 70°.

Although a recent report indicated that a stem-end rot (*Phomopsis* sp.) of Chinese gooseberries was found in Chicago on fruit imported from New Zealand (2), no postharvest diseases developed in California fruit during our storage and ripening studies.

LITERATURE CITED

- (1) ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.
1945. OFFICIAL AND TENTATIVE METHODS OF ANALYSIS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. Assoc. Off. Agr. Chem., Washington, D.C. 390 pp.
- (2) BERAHA, L.
1970. STEM-END ROT OF CHINESE GOOSE BERRY (*ACTINIDIA CHINENSIS*) ON THE MARKET. U.S. Dept. Agr., Plant Dis. Rptr. 54(5): 422-423.
- (3) BOURNE, M. C.
1967. DEFORMATION TESTING OF FOODS. 1. A PRECISE TECHNIQUE FOR PERFORMING THE DEFORMATION TEST. Jour. Food Sci. 32(5): 601-605.
- (4) CURLEE, DON.
1970. KIWI, THE UGLY VISITOR FROM "DOWN UNDER" FINDS A NEW HOME IN THE WEST. West. Fruit Grower 24(8): 8-14.
- (5) FLETCHER, W. A., BAUMGART, M. G., and PIPER, B. M.
1959. HANDLING CHINESE GOOSEBERRIES FOR LONG STORAGE AND EXPORT. New Zeal. Jour. Agr. 99: 15-16.
- (6) ——— and PIPER, B. M.
1961. PACKAGING CHINESE GOOSEBERRIES FOR STORAGE AND EXPORT. New Zeal. Jour. Agr. 102: 289-290.
- (7) PADFIELD, C. A. S., and BAILEY, F. L.
1952. CHINESE GOOSEBERRIES (*ACTINIDIA CHINENSIS*): A SURVEY OF THEIR BEHAVIOUR IN COOL-STORAGE AT ALL STAGES OF HARVEST MATURITY FROM MAY TO JULY. New Zeal. Jour. Sci. and Technol. 33(5): 113-116.
- (8) ——— and BRIDGMAN, M. J.
1950. EFFECT OF TEMPERATURE ON CHINESE GOOSEBERRIES IN COOL STORE. New Zeal. Jour. Sci. and Technol. 31(6): 61-63.
- (9) SCHROEDER, C. A., and FLETCHER, W. A.
1967. THE CHINESE GOOSEBERRY (*ACTINIDIA CHINENSIS*) IN NEW ZEALAND. Econ. Bot. 21: 81-92.
- (10) SMITH, R. C.
1961. CHINESE GOOSEBERRY. PROMISING NEW FRUIT CROP WITH A UNIQUE FLAVOR AND A VARIETY OF COMMERCIAL USES. West. Fruit Grower 15(10): 19-20.
- (11) WRIGHT, H. B., and HEATHERBELL, D. A.
1967. A STUDY OF RESPIRATORY TRENDS AND SOME ASSOCIATED PHYSIO-CHEMICAL CHANGES OF CHINESE GOOSEBERRY FRUIT *ACTINIDIA CHINENSIS* (YANG-TAO) DURING THE LATER STAGES OF DEVELOPMENT. New Zeal. Jour. Agr. Res. 10: 405-414.